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Ecological study of gas fields in the northern Adriatic

12. Ecological features of the benthic community

Ante ŠPAN, Boris ANTOLIĆ, Ante ŠIMUNOVIĆ, Ivana GRUBELIĆ and Stjepan JUKIĆ

Institute of Oceanography and Fisheries, Split, Croatia

During the period from 1982 to 1985 and at the beginning of 1986 floristic and faunistic compositions and distributions of benthic communities of southwestern rocky coast of Istra (cape Proštine to Cape Kamenjak on Premantura peninsula) and of deeper mobile bottoms of open waters towards the IVANA field were studied. Benthic flora consisted of 245 species and intraspecific taxa of multiceluar algae (Rhodophyta 146 taxa, Phaeophyta 57 taxa, Chlorophyta 42 taxa) and 2 species of seagrasses.

Benthic algal settlements on a greater coastal part are characterized by numerous species and infraspecific taxa (246) that inhabit solid (rocky and stone) bottoms. Other considerable surfaces of the deeper mobile (sediment) bottom in the open part of the studied area have almost no phytobenthic settlements at all, because only 15 species were determined there. At certain parts of the studied coast from Cape Proština (near Pula) to Cape Kamenjak, especially in shallow water phytobenthic settlements, progressive phases of degradation process were noticed due to the negative imapct of the increased sea pollution.

Regarding quality and quantity zoobenthic settlements are well developed and cover 299 macrozoobenthic species from nine systematic groups. The distribution of these settlements at deeper mobile bottoms of the open part is characterized by high total and mean values, but shows considerable variations in relation to the mechanical structure of the sediment at certain parts of the studied area. It was noticed that at mostly silty bottoms, species from the Arthropoda group dominate by quantity and quality, while sandy bottoms are dominated by species from the Mollusca and Echinodermata groups.

Ichthyological (groundfish stock) settlements are well developed at mobile bottoms of the wider area of the IVANA and IKA fields which is well confirmed by the rather high total amounts of the quantity of the zoobenthos of 47 950 t, of which the edible part (fish, crustaceans, shellfish and cephalopoda, total 6 680 t and nonedible 41 270 t. From the point of view of fisheries and economy the wider area of gas fields, due to the abundancy and variability of edible resources, represents a significant part of the open Adriatic fishing grounds.

12.1. INTRODUCTION

On the basis of gathered floristic and faunistic material from the southwestern coastal part of Istra to the IVANA field, from 1982 until 1986, the quality and quantity of the distribution of benthic settlements has been studied. The study covered phytobenthic and zoobenthic settlements of the littoral rocky and open mobile bottom. Special attention was given to ichtyobenthic settlements at the deeper mobile bottoms of the wider IVANA field.

12.2. MATERIAL AND METHODS

During 1982, 1983, 1984, 1985 and the beginning of 1986 the floristic and faunistic material was gathered at the furthest southwestern part of Istra (from Cape Proština to Cape Kamenjak on the Premantura Peninsula) and at the deeper open area towards the IVANA field and on it. In the coastal part sampling was carried out at a number of stations along 4 profiles (2 in the Štinjan Bay near Pula and 2 on the Premantura Peninsula) in supralittoral, mediolittoral and infralittoral zone up to 25 (30) m deep (Fig. 12.1.).

Also used was the material from two cruisings carried out by vessel PIPETTA in May - June and November - December 1982 in international waters as well as two stations (B9 and C/) within the Croatian territorial waters in May 1983. Data with two profiles covering the IVANA and IKA field were applied. Stations 2, 3, 4, 5, 6, 7, 8 and 9 were applied from B profile and from the C profile 2, 3, 4, 5, 6 and 7 (Fig. 12.2.).

A number of other sources of relevant data from works of earlier and recent authors were applied in this paper.

Standard sampling and observation methods of benthic settlements were applied in the study, direct method by means of SCUBA diving and indirect by means of various implements and devices that were used for sampling from the vessel or the sea surface. At more solid (rocky and stone) bottoms, the direct method of transects was applied (profiles) on which at various depths in the mediolittoral

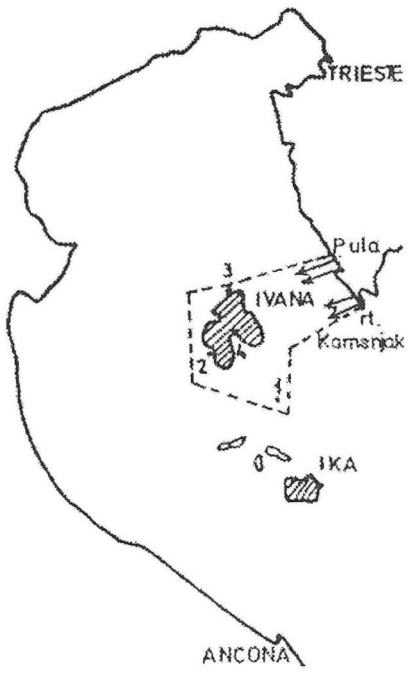

Fig. 12.1. Studied area of benthic settlements. Four transects are marked

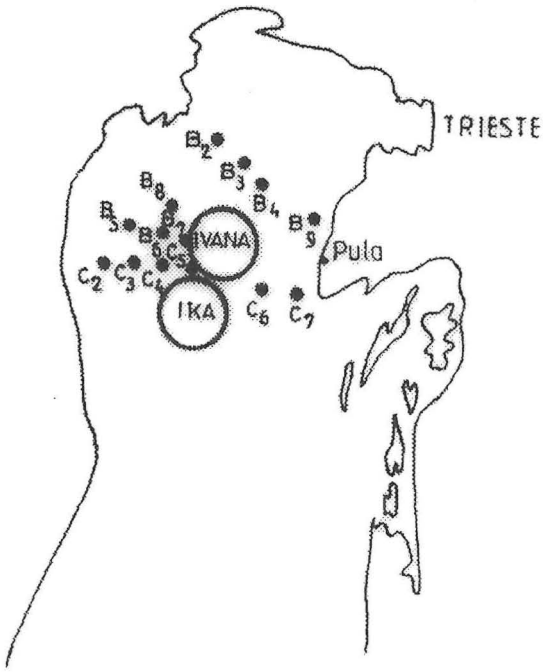

Fig. 12.2. Stations from cruising by PIPETTA (B and C profiles)

and infralittoral, complete samples were taken in settlements from a surface of 20 x 20 cm, or at mostly mobile bottoms from a surface of 50 x 50 cm. At deeper mobile (sedimental) bottoms, dominated by faunistic settlements, whose quality changes rather slow in the function of depth and mechanic composition of the sediment, sampling was carried out at numerous stations by means of benthic bottom samplers and dredges, and very rich zoological material obtained by bottom trawl was applied. In the open parts of the northern and central Adriatic, the ichtyobenthos was particularly studied (biomass and relative abundancy) demersal edible settlements at mobile bottoms, where the bottom trawl (Italian type) was used as well as the "swept area" method (PAULY, 1982), by means of which the edible biomass of the ground fish stock (standard haul) was calculated according to the formula:

$$B = \frac{c/f \cdot A}{a \cdot x_1}$$

12.3. RESULTS

12.3.1. Phytobenthos

12.3.1.1. Floristic composition

The study of the gathered floristic material enabled to determine a total of 245 taxa (species, subspecies, varieties, forms and stadia) of multicellular benthic algae and 2 species of seagrasses (Table 12.1.). The determined algae species are divided into three main systematic phyla (Rhodophyta, Phaeophyta and Chlorophyta) and 5 classes (Bangiophyceae, Florideophyceae, Phaeopyceae, Chlorophyceae and Bryopsidophyceae) with a total of 28 orders, 51 families and 123 genera. By number and percentage, absolutely the most present are representatives of the Rhodophyta phylum (Bangiophyceae and Florideophyceae) with 147 taxa i.e. 60.0%, followed by 56 taxa and 22.3% of representatives of the Phaeophyta phylum and by 42 taxa, i.e. 17.7% of representatives of the Chlorophyta phylum. In his well-known work "Compendio della flora e fauna del Mare Adriatico presso Rovigno" VATOVA (1928) wrote that all benthic algae species at the wider area of Rovinj (from Cape Petalon to the Sestrice Island) then described, a total of 391 taxa (Rhodophyta 215 (55.0%), Phaeophyta 81 (20.7%) and Chlorophyta 95 (24.3%) as well as 4 seagrass species.

With regard to that inventory, the present one is poorer and covers only 63% of algal species given by VATOVA. It should also be noted that ecological circumstances along the western Istrian coast have since then, and in particular in the last twenty years, considerably changed due to an ever increasing intensity and a greater area of polluted sea. Present settlements of benthic algae are therefore greatly degraded by quality and quantity, and a great number of algae have disappeared from that area. By direct method (scuba diving), on 24 transects and at 75 stations from Savudrija to Cape Kamenjak and by means of indirect sampling with the bottom sampler and dredge, ZAVODNIK, M (1983) determined only 165 taxa of benthic algae and 2 seagrass species, which is 42% of the taxa given by VATOVA (1928) from the wider area of Rovinj.

From the given data on values of the R/P quotient it can be said that the present benthic algal flora, of considerably degraded quality though, as well as the ratio of the representatives of the Rhodopyta and Phaeophyta are nearly equal at certain compared parts of the western Istrian coast (VATOVA, 2.65; ZAVODNIK, N. 2.75; ŠPAN and ANTOLIĆ 2.6). Comparing the data by Vatova and Zavodnik, the greatest percentage of species decrease was determined in the Chlorophyta group (65.3%). It is necessary to underline that recent research of the benthic flora along the west Istrian coast (MUNDA, 1980, ZAVODNIK, N. 1983) proved it considerably changed by quality and in particular the quantity due to the abundant settlements of various species

Table 12.1. Number of orders, families, genera, species, subspecies, varietas, formes and stages in different divisions and classes.

DIVISIONS Classes	Orders	Families	Genera	Species	Subspecies	Varietas	Formes	Stages
RHODOPHYTA								
Bangiophycease	2	3	5	8	-	-	-	-
Florideophycease	8	20	77	125	-	12	1	1
	10	23	82	133	-	12	1	1
PHAEOPHYTA								
Phaeophycease	9	17	33	46	2	5	2	2
CHLOROPHYTA								
Chlorophycease	3	4	5	11	-	-	-	-
Bryopsidophycease	6	7	12	30	-	-	-	1
	9	11	17	41	-	-	-	1
TOTAL	28	51	132	220	2	17	3	4

genera of the *Cystoseira* (especially the *Cystoseira barbata* and the *C. compressa*) and due to the great expansion of settlements of a greater number of nitrophylous species, of which the most significant belong to the Chlorophyta division, especially species from the genera *Enteromorpha*, *Cladophora* and *Ulva*, but also those belonging to the Phaephyta and the Rhodophyta. The given percentage decrease of the number of species was the least in the Phaephyta division (48%) and somewhat greater in the Rhodophyta division (55%). On the contrary the largest percentage decrease of algal species in relation to our data and earlier ones of VATOVA (1928) were in the Phaeophyta division (44.6%), less in the Chlorophyta division (37.9) and the least in the Rhodophyta phylum (31.6%). This explains the nearly identical values of the R/P quotient in research of the benthic flora at certain narrow or wider parts of western Istria at various times.

12.3.1.2. The distribution of the benthic flora in the studied area

The analysis of distribution (vertically and horizontally) of benthic algae revealed that the greatest number of species was distirbuted in the coastal part of the studied area at submerged parts of the rocky coast and at stone bottoms beneath them, while at mobile bottoms, somewhat further from the coast, the flora of the benthic algae was poorly developed and according to the number of species very modest. At deeper mobile bottoms at the open sea only 13 taxa were found (Table 12.2. in Annex). The benthic flora richest in species grows on a mostly rocky coast that stretches from several decimetres below the sea surface to a depth of 15 and at some places 20 - 25 m. On gently inclined rocky and stone bottoms, that are only partly covered by sandy sediment, settlements of various species of the Cystoseira genus are developed (*C. barbata*, *C. compressa*, *C. crynitopylla* and *C. schiffneri*, and somewhat deeper the *C. adriatica*, *C. corniculata* ssp. laxior and *C. schiffneri* var. *latiramosa*) that are presently greatly rarified in relation to the earlier abundantly developed ones (ŠPAN, 1969b).

In general settlements of various species of the *Cystoseira* genus, both in the Adriatic and the Mediterranean, are phytophorals of the developed flora of epiphytic and epilytic algae. The most prominent by the richness of epiphytic algae are settlements of the *Cystosteira barbata*, *C. adriatica* and *C. compressa* species that are in this regard best studied in the Adriatic (ŠPAN and ANTOLIĆ, 1981, 1984, 1985, 1988).

With regard to the deepwise distribution, it is known that the smallest number of benthic algae, with the exception of microphytobenthic taxa from the Cyanophytae phylum, grows, in the supralittoral bionomic zone, where the *Catenella repens* is still very common and in supralittoral rock-pools, in particu-

lar species of the *Blindingia minima*, the *Enteromorpa compressa*, *Cladophora glomerata* and the *C. dalmatica*.

In the mediolittoral zone that comprises part of the coast within variations of sea tides much more of them have been determined - a total of 45 taxa from the Rhodophyta division, Phaeophyta and Chlorophyta. The infralittoral zone that comprises the constantly submerged part of the rocky coast and stone and detritus bottoms, is inhabited by a versatile flora of benthic algae, that according to our research, presently comprises about 200 taxa. Reversely, only few remains of the earlier rather extensive settlements of the *Posidonia oceanica* can be found at mobile bottoms and in more shallow coves the *Cymodocea nodosa* can be found. As a comparison, it must be said that VATOVA (1928) listed 330 species of benthic algae in the bionomic zone of the infralittoral at the greater Rovinj area.

Presently, these infralittoral settlements of the *Cystoseira* species as well as seagrass settlements along the western Istrian coast are in constant regression due to the increasing sea pollution. Studying the impact of organic sea pollution on the distribution, especially of the Fucacean algal associations in the Rovinj littoral and nearby islands in 1978 - 1980, MUNDA (1980) determined that the distribution of the settlements of the *Cystoseira*, *Sargassum* and *Fucus* was radically restricted to the western Istrian coast in relation to the condition in the settlements, that MUNDA (1979) determined ten years earlier. Settlements of the *Cystoseira* (*C. crinita* and *C. amentacea* var. *spicata*) that were most sensitive to pollution vanished away. Settlements of species such as *Cystoseira compressa*, *C. barbata* and *Fucus virsoides* proved to be somewhat more resistent. This benthic community was at the greater west Istrian coast replaced by settlements of mostly nitrophylous algae vegetation dominated in particular by species of genera *Enteromorpa*, *Blindingia*, *Dictyopteris*, *Dictyota*, *Spyridia*, *Gelidium*, *Porphyra* and many others. Equal improverishment and gradual vanishing was also noticed in seagrass settlements, in particular the *Posidonia oceanica*, *Zostera marina* and *Z. noltii* (ZAVODNIK, N. 1983).

12.3.1.3. Quantitative relationships in the benthic floral settlements

The knowledge of quantity relations in settlements of Adriatic benthic algae is still very scarce. From 1962-1968 a quantity assessment of the dominant species of the *Cystoseira* genus was made on a 1300 km long coast approx. and the islands of the eastern Adriatic, that covered surface settlements at a depth of up to 4-5 m (ŠPAN, 1964, 1969a, b). Within these studies, the assessment of the *Cystoseira* quantity was made on the west Istrian coast (ŠPAN, 1974). It was determined that this area was among the richest in the Adriatic by the *Cystoseira*. At about 156 km of studied coast, the total assessed quantities were 2560 t of wet weight, which was a little more than one fourth of the totally assessed quantities on 1300 km of the Adriatic coast These quantities were unequally distributed, because certain segments of the shallower rocky bottom were covered by abundant and extensive settlements of various *Cystoseira* species. The mean value of the biomass was at the time 2.2 kg/m^2 (including also the negative stations at which poorly developed settlements of these species were found or were not found at all). On one kilometre of the studied coast the estimated mean values of quantities of the *Cystoseira* were 16.4 t. According to some data by MUNDA (1974), the dominating species in the Rovinj area was the *Cystoseira barbata* whose minimum biomass value in springtime varied from 1829 to 5000 g/m^2 and the maximum in summertime from 2940 to 9560 g/m^2. The *Cystoseira compressa* specie was less represented and its biomass varied from 1374 to 1680 g/m^2 in springtime and to 3160 g/m^2 in summertime.

12.3.2. Zoobenthos

12.3.2.1. Faunistic composition

Studying the collected faunistic material in benthic coastal settlements and the open part of the deeper bottom towards the IVANA field (Fig. 12.1.), 299 macrozoobenthic species were determined (Table 12.3. and Table 12.4. in Annex). By the number of species, the first was the group of Mollusca with 92 and Pisces with 62 species, followed by Porifera with 36, Arthropoda with 32, Echinodermata with 31, Annelida with 13, Tunicata with 13, Cnidaria with 11 and Tentaculata with 9 species.

12.3.2.2. Distribution of the benthic fauna

Differences in the distribution (horizontal and vertical) of macrozoobenthic species in the coastal and open area, compared to the floristic species are much less pronounced. The quality structure and quantity relations between zoobenthic settlements in the coastal and open area are very different, especially regarding the physical composition of the bottoms in those areas. The mobile sediment bottoms, unlike the solid bottoms have more species and also biomass, because they bear considerable quantities of edible (fish, cephalopods, shellfishes, crabs) and inedible zoobenthos. At deeper mobile bottoms of the open area, 195 species, divided into 9 groups were determined, among which the dominant by the number of species are Pisces (62), Mollusca (42), Arthropoda (24), Echinodermata (24) and Porifera (20), while other groups (Cnidaria, Annelida, Tentaculata and Tunicata) were represented with a fewer number (9-13) of species. In the coastal area, the same groups are differently represented by species, so Mollusca with 61 species is much more represented than in the open area, while Echinodermata with 16 and Arthropoda with 10 species. In the coastal area they are among the most numerous species, but have much less species than in the open area. In other groups the following was determined: Porifera 12, Cnidaria 5, Annelida 8, Tentaculata 9, and Tunicata 11. In the coastal part of the studied area, only 10 species of Pisces (Osteichthyes) were determined. It may be concluded that certain bionomic zones with zoobenthic communities are very well differentiated by the presence of larger majority of characteristic species for each single zone (supralittoral, mediolittoral and infralittoral).

Table. 12.3. Number of species of benthic fauna in the coastal (I), open (II) and all (Total) study area

	Coastal area I	Open area II	Total area	Common species
Porifera	21	20	36	5
Cnidaria	5	6	11	0
Annelida	8	8	13	3
Arthropoda	10	24	32	2
Mollusca	61	42	92	11
Tentaculata	9	2	9	2
Echinodermata	16	24	31	9
Tunicata	11	7	13	5
	141	133	237	37
Pisces	10	62	62	10
TOTAL	151	195	299	47

12.3.2.3. Qualitative and quantitative relations within the zoobenthos

At 14 earlier mentioned stations in the open area distributed on profiles B and C of the PIPETTA expedition (1982-1983) studies of the qualitative and quantitative composition of zoobenthic settlements by presence of species were made. (Fig. 12.2.). Some results were published in the papers of JUKIĆ and PICCINETTI (1981), PICCINETTI and JUKIĆ (1983), PICCINETTI et al. (1985), ŠIMUNOVIĆ and JUKIĆ (1983). Table 12.5. in Annex gives total and mean values of the quality of certain zoobenthic systematic categories at 14 stations distributed along the studied B and C profiles. Particularly prominent by the high values of total and mean quantities are the Mollusca categories with 3 315 kg, i.e. an average of 237 kg and the somewhat lesser Arthropoda with 1 641 kg, i.e. 117 kg and the Echinodermata with 1 273 kg i.e. 90 kg. The lowest values of the total and mean values of the quantity with 4.2 kg, i.e. 0.3 kg at all stations were in the Annelida category. It was generally noticed that quantities of each single category considerably varied at certain stations, sometimes even for several orders of magnitude as for example in the Mollusca category where the variations were from 0.98 kg at station B8, 45.43 kg at station B7 to 1 148 kg at station C6. In relation to the total quantities of all studied systematic categories, the greatest mean values were found at stations C6 (1 494), C5 (1 213 kg), and the lowest at stations C2 (82.0 kg), B7 (114.2 kg) and B5 (151 kg).From the aforementioned percentages it is possible to determine the number of specimens and the weight of certain faunistic groups at stations (Fig. 12.2.) B and C profile, their numerical and weight presence and frequency, as well as the changes of these relations from one station to another.The analysis of the biomass and the number of specimens of certain systematic categories in relation to the mechanical composition of the sediment at stations showed that at mostly silty bottoms the predominant are the Arthropoda, while the mostly sandy bottoms were dominated by Mollusca and Echinodermata (Figs. 12.3., 12.4., 12.5. and 12.6.).

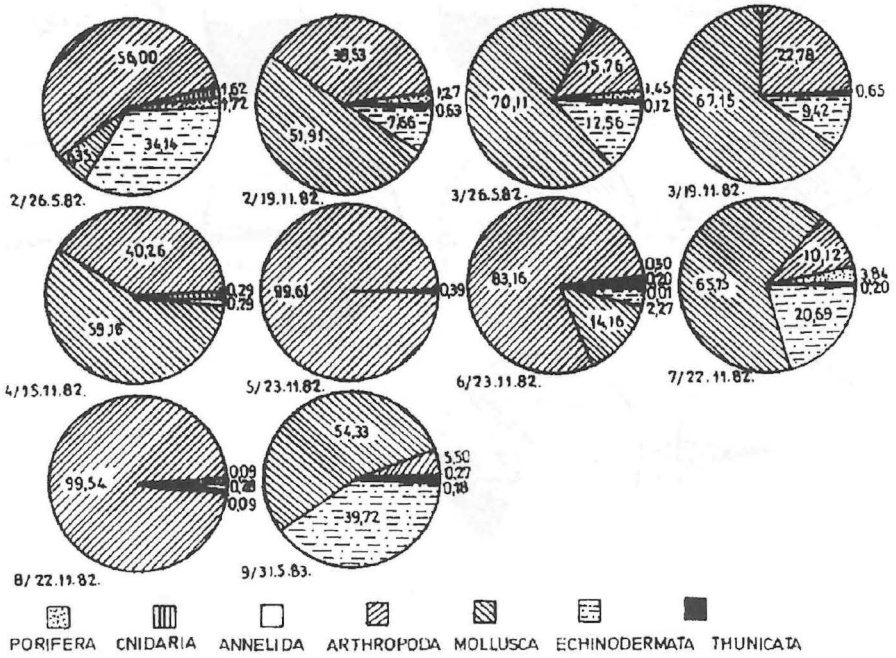

Fig. 12.3. Percentage ratios of certain faunistic groups at profile B stations (bottom trawl)

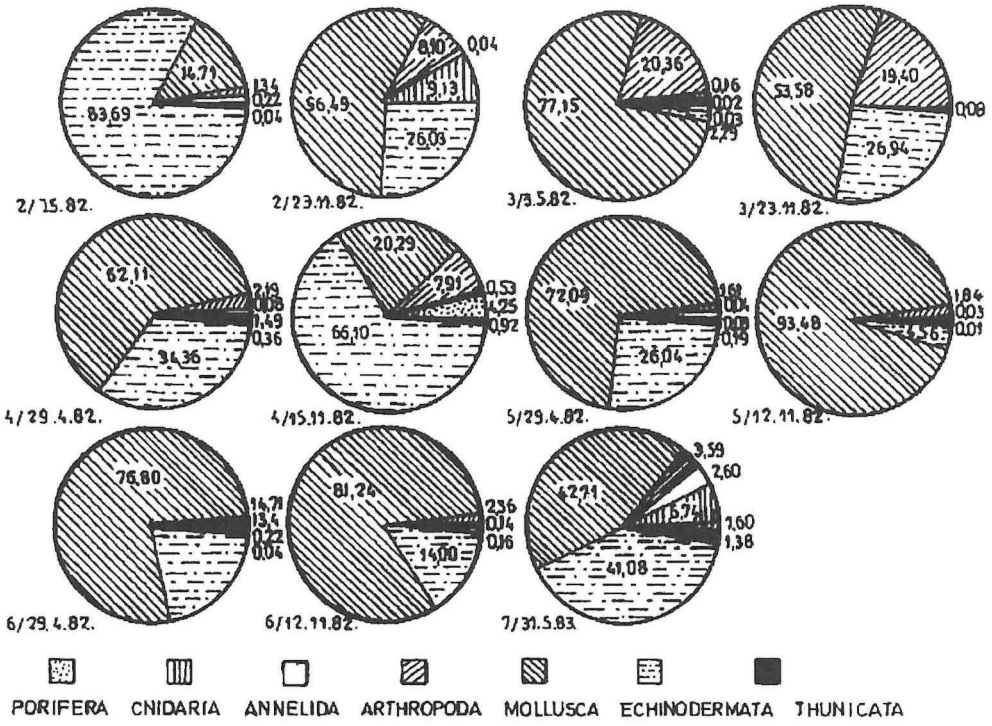

Fig. 12.4. Percentage ratios of certain faunistic groups at profile C stations (bottom trawl)

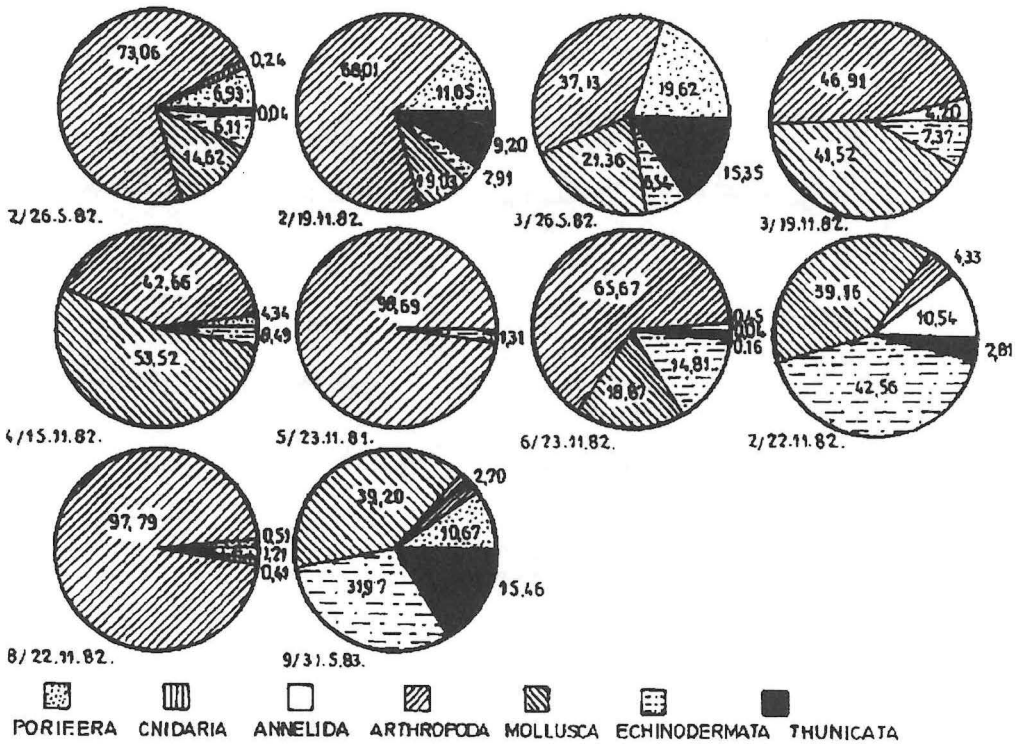

Fig. 12.5. Percentage ratios of the weight of certain faunistic groups at C profile (bottom trawl)

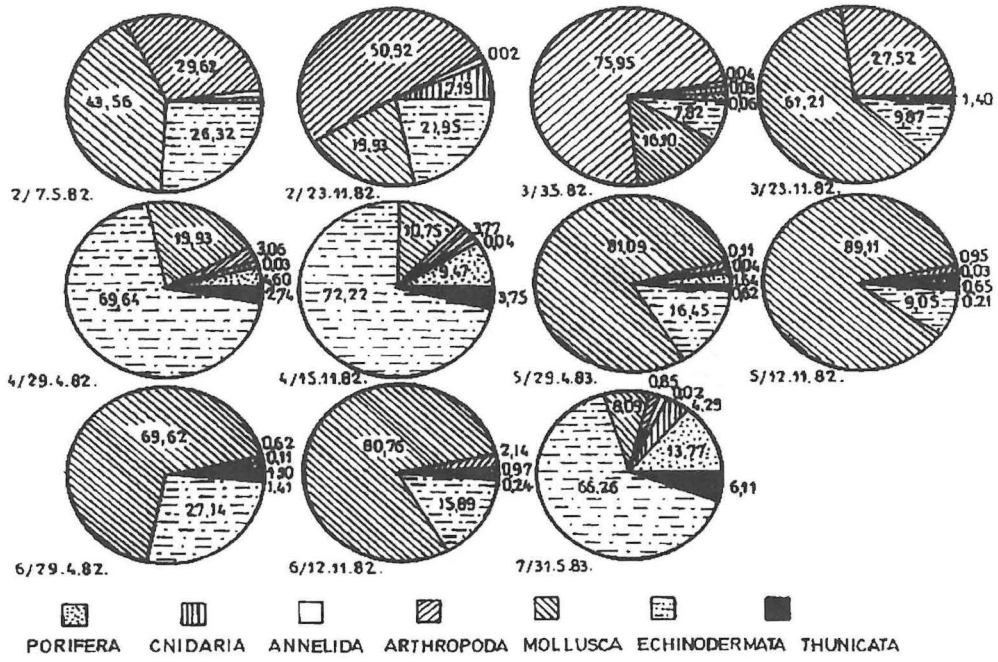

Fig.12.6. Percentage ratios of certain faunistic groups of profile C stations (bottom trawl)

12.3.3. Groundfish stocks

Groundfish stocks in the northern Adriatic include fish species that are divided in two classes: the Chondrichthyes and the Osteichthyes, but broadly speaking they ecompass also species of other systematic categories of the zoobenthos, especially the Cephalopoda, Lamellibranchiata and Crustacea-Decapoda, that have an economical value as human nutrition. The faunistic settlements are formed on various mobile bottoms and form various biocoenoses that are absolutely dominated by the faunistic component. Sampling of the complete settlement was perfomed by the bottom trawl net, and each sample was studied as its edible and nonedible part. These studies carried out by the fishing and biological expedition PIPETTA joint programme between laboratories in Split and Fano (Italy) in the northern and central Adriatic, obtained data that refer to the greater area than that of the IVANA gas field (Fig. 12.7.), and that covered 14 stations distributed at B and C fixed profiles with four types of

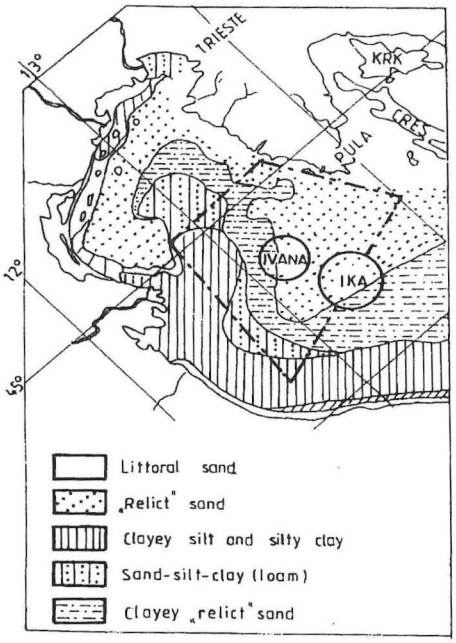

Fig. 12.7. Seabottom composition at the studied area according to Laboratorio di geologia marina, CNR, Italia . Also marked is the area with calculated biomass and zoobenthic and ichthyobenthic ratios*

** Map taken from ANNEX (E) E "Distribution des sediments/Sediment distribution" of the Report of the Second Technical Consulation on Stock Assessment in the Adriatic. FAO Rapp. Peches, /253), p.49.*

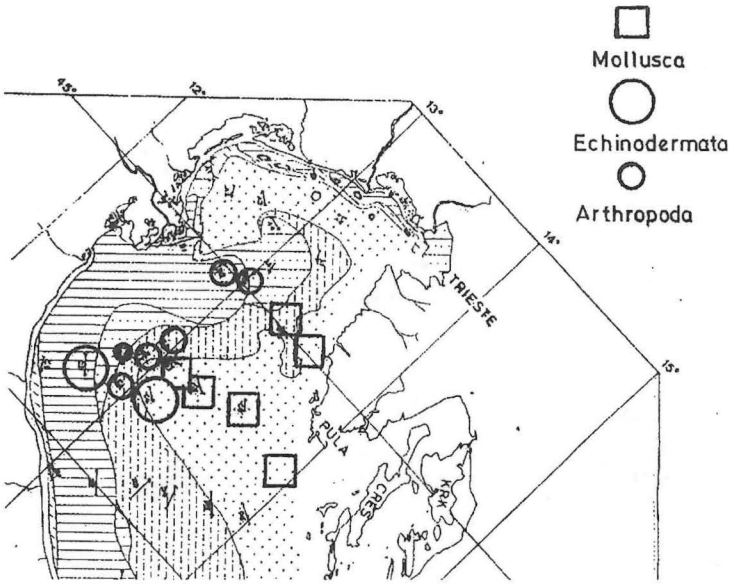

Fig. 12.8. Dominant groups per number of specimens at stations (average value of two cruisings)

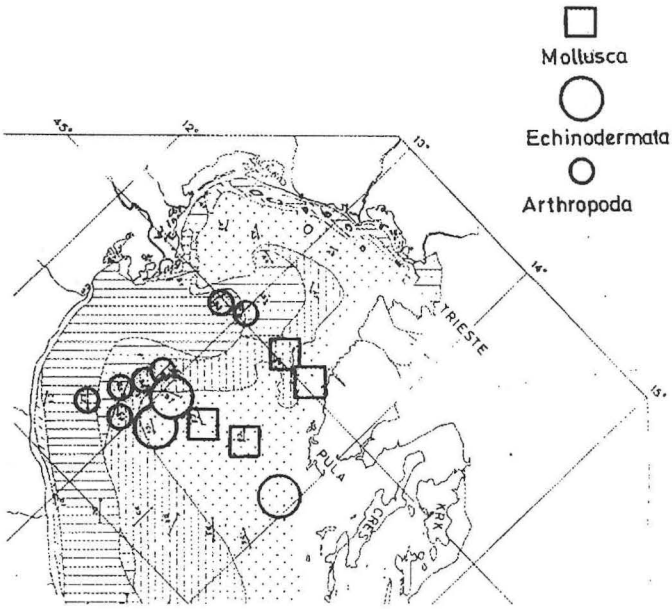

Fig. 12.9. Biomass of dominant groups at stations (average value of two cruisings)

bottom sediment: "relict" sand, clayey silt and silty clay, sand-silt-clay (loam) and clayey "relict" sand. (Figs. 12.8. and 12.9.).

The quantitative values of the main systematic groups as well as the percentage of mean values of edible and nonedible parts of the catches are given (Table 12.6.). The entire quantity of the zoobenthic biomass totalled 47 950 t. The share of the nonedible part of the bottom trawl catch made 41 270 t and greatly surpasses the edible part of the catch that amounts 6 680 t and represents 13.9% of the

total zoobenthic biomass in the studied area. Within the edible part of the trawl catch, the greater part of caught fish is divided in two classes: Osteichthyes (4 789 t) and Chondrichthyes (538 t) and the Cephalopoda (1 307 t) and Crustacea-Decapoda (48 t). The nonedible part, is mostly represented by the biomasses of Mollusca (20 650 t) and Arthropoda Crustacea (10 180 t), while the biomass of other sea organisms is much lesser.

In order to assess the economic and fishing and productive significance of the northern Adriatic, the fishery statistical data on the catch of corresponding fish and edible organisms for 1979 for Italian commercial fishing boats (Annuario Statistico 1980) is set forth from which it is evident that only 209 800 quintals or 12.3% of the total 1 704 430 quintals of fish species are caught in the southern Adriatic. The annual catch of Cephalopoda (squd, cuttle-fish, Eledone moschata) add up to 120 440 quintals of which 33 260 quintals (27.6%) are caught in the southern Adriatic. The catch of Crustaceans (shrimp, lobster and prawn) totalled 72 410 quintals in 1979 of which 18 970 quintals (26.2%) is

Table 12.6. Structure and quantity of demersal resources (groundfish stocks): edible and non-edible biomass during 1982-1983 year in wider fishing region around IVANA gas field

Main group of demersal organisms	Total quantity in catch kg	Percentage of the group in catch %	Average value per catch kg	Total biomass in studied area kg
VERTEBRATA				
Chondrichthyes	160.43	14.87	6.17	538 169
Osteichthyes	713.54	66.2	27.45	4 788 578
MOLLUSCA				
Cephalopoda	194.63	18.0	7.49	1 306 610
ARTHROPODA				
Crustacea (Decapoda)	10.94	1.0	0.55	47 969
Total edible				6 681 326
Porifera	228.46	3.4	16.32	1 423 483
Chidaria	22.86	0.3	1.63	142 175
Annelida	4.20	0.1	0.30	26 167
Arthropoda	1641.26	24.7	117.23	10 177 259
Mollusca	3315.17	49.9	236.79	20 653 688
Echinoderma	1273.00	19.1	90.93	7 931 246
Tunicata	153.28	2.3	10.95	955 098
Total non-edible				41 266 385
Total biomass (edible and non-edible)				47 974 711
Percentage of edible biomass	13.93			
Percentage of non-edible biomass	86.07			

realized in the southern Adriatic. Shellfish catch of 24 510 quintals, 4 280 quintals (17.5%) is caught in the southern Adriatic. Though given statistical data derive from inadequate fisheries statistics (general characteristics from Mediterranean commercial fisheries), in this case Italian commercial landing of fishing boats in 1979 confirms a greater significance of the organic production (secondary production) in the northern Adriatic in comparison to other Adriatic sea regions.

12.4. CONCLUSIONS

Benthic settlements in the wider area of the IVANA field are generally well developed, in particular the zoobenthic settlements on mobile deeper bottoms in the open area of the studied area.

The composition of benthic fauna consisted of 299 macrozoobenthic species. The most abundant was the group Mollusca with 92, and Pisces with 62 species, followed by Porifera with 36, Arthropoda with 32, Echinodermata with 31, Tunicata with 13, Annelida with 13, Cnidaria with 11 and Tentaculata with 9 species. Vertical and horizontal distribution of behthic flora and fauna were analysed. The greatest number of algal taxa (253) was determined in the coastal part of the studied area on submerged parts of the rocky coast and on rocky bottoms beneath them, while on mobile bottoms, somewhat further from the coast, flora was poorly developed. On deeper mobile bottoms of open waters only 14 algal taxa were found. The richest benthic flora grows on rocky coast that stretches from nearly surface to the depth of 15, and at some places 20-25 m. On gently inclined rocky and stone bottoms only partially covered by sand, communities of various species of *Cystoseira* genus developed. These communities of *Cystoseira* are very rich of epiphytic and epilytic algal taxa. The distribution in bionomic zones was analysed. In mediolittoral a total of 45 taxa have been noted. The infralitoral zone, which comprises part of the rocky coast, rocky and detritic bottoms, comprised about 200 taxa. Presently, these infralitoral communities of *Cystoseira* species as well as seagrasses comunities along the western Istrian coast are in constant regression due to the increasing sea pollution.

Differecens in distribution (horizontal and vertical) of macrozoobenthic species in coastal and open waters, compared to the floristic species are much pronounced. The quality-quantity structure of zoobenthic communities in the coastal and open waters are very different, especially regarding physical composition of the bottom. Solid bottoms have more species and higher biomass. Regarding quality and quantity, zoobenthic comunities are well developed and consist of 299 macrozoobenthic species from nine systematic groups. Distribution of zoobenthic communities on deeper mobile bottoms of open waters are characterized with high values, but differ considerably in relation to the bottom structure. It was noticed that at mostly silty bottoms Arthropoda species dominate both in qualitative and in quantitative aspect, while Mollusca and Echinodermata groups dominate on sandy bottoms. Ichtyological settlements are well developed on mobile bottoms of the wider area of IVANA and IKA fields. The rather high total amount of zoobentos (47 950 t) was confirmed, out of which edible part (fish, shellfish and cephalopods) comprised 6 671 t and nonedible 41 237 t.

From the point of view of fishery and economy the wider area of gas fields, due to the abundancy and variability of edible resources, represents a significant part of the open Adriatic fishing grounds.

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Ekološka studija plinskih polja u sjevernom Jadranu

Ekološke osobine bentoskih zajednica

Ante ŠPAN, Boris ANTOLIĆ, Ante ŠIMUNOVIĆ, Ivana GRUBELIĆ i Stjepan JUKIĆ

Institut za oceanografiju i ribarstvo, Split, Hrvatska

KRATKI SADRŽAJ

Na području jugozapadne stjenovite obale Istre (od rta Proština do rta Kamenjak na poluotoku Premantura) i na dubljim pomičnim dnima prema otvorenom moru, te u plinskim poljima IVANA i IKA, obavljena su u razdoblju od 1982. do 1985. i početkom 1986. godine istraživanja sastava i rasprostranjenosti flore i faune (uključujući i ihtiofaunu) u životnim zajednicama morskog dna. U bentoskoj je flori određeno 245 svojti bentoski alga (Rhodophyta 146 svojti, Phaeophyta 57 svojti, Chlorophyta 42 svojte) i 2 vrste morskih cvjetnica.

U sastavu je bentoske faune određeno 299 makrobentoskih vrsta koje su razvrstane u devet sitematskih skupina. Najbrojniji su Mollusca s 92 vrste, a slijede ih Pisces sa 62 vrste, Poryphera s 36 vrsta, Tunicata s 32 vrste, Echinodermata s 31 vrstom, Arthropoda s 13 vrsta, Annelida s 13 vrsta, Cnidaria 11 vrsta i Tentaculata s 5 vrsta.

Analiza je vertikalne i horizontalne rasprostranjenosti bentoske flore i faune pokazala da je najveći broj svojti betonskih alga (253) zabilježen u naseljima razvijenim na stjenovitoj i kamenitoj obali, dok su na dubljim i pomičnim (sedimentima) dnima koja se protežu od polja IVANA i IKA, ta naselja vrlo skromno razvijena. Na tim dnima je određeno samo 13 svojti bentoskih alga.

Bentoska je flora najbolje razvijena na stjenovitim dijelovima obale od površine do 15 (16) m, a mjestimice do 20 (25) m dubine. Na blaže nagnutim stjenovitim i kamenitim dnima koja su samo djelomično prekrivena tankim pješćanim sedimentima naseljavaju se razne vrste roda Cystoseira u čijim naseljima su nazočni dosta brojni epifitski i epilitski oblici bentoskih alga. U mediolitoralu je određeno 45 svojti, a u infralitoralu oko 200 svojti bentoski alga. Naselja su rodova *Cystoseira*, *Fucus* i *Sargassum* na zapadnoj obali Istre u stalnoj regresiji radi onečišćenja mora.

Analiza vertikalne i horizontalne raspostranjenosti makrozoobentoskih vrsta je pokazala da su razlike u priobalnoj i otvorenoj zoni znatno manje nego u odnosu na floristički sastav. Kvalitativna građa i kvantitativni odnosi između zoobentoskih naselja su na obim zonama jako različita, osobito u odnosu na različitosti mehaničkog sastava morskog dna. Čvrsta dna imaju više vrsta i biomasu, pogotovo jer obuhvaćaju značajne količine jestivog zoobentosa (bodljikaši, žarnjaci i spužve). Utvrđeno je da skupina člankonožaca znatno prevladava kvalitativno i kvantitativno uglavnom na muljevitim dnima, dok na pješćanim dnima prevladavaju vrste iz skupina mekušaca i bodljikaša.

Ihtiološka su naselja vrlo dobro razvijena na pomičnim dnima koja uključuju polja IVANA i IKA. Potvrđeno je da ona sadrže dosta visoke ukupne količine zoobentoskih vrsta (47 950 t), od čega na jestivi dio otpada 6 680 t, a na nejestivi 41 237 t. Glede ribarstva i gospodarstva ta opsežna područja predstavljaju radi raznolikosti i obilnosti jestivih zaliha, značajan dio ribarskih dna Jadranskog mora.

ANNEX

Table. 12.2. List of determineted phytobenthic taxa and their relative abundance (r = rare, x = 1-10, c = 10-100, cc = >100 individuals m^2

	I Coastal area	II Open sea area
RODOPHYTA		
BANGIOPHYCEAE		
P o r p h y r i d i a l e s		
Goniotrichaceae:		
Chroodactylon ornatum (C. Agardh) Drew et Rose	x	-
Goniotrichum alsidii (Zanardini) Howe	x	-
Goniotrichum cornu-cervi (Reinsch) Hauck	x	-
B a n g i a l e s		
Bangiaceae:		
Bangia atropurpurea (Roth) C. Agardh	c	-
Porphyra leucosticta Thuret in Le Jolis	cc	-
Erythropeltidaceae:		
Erythrotrichia carnea (Dillwyn) J. Agardh	c	-
Erythrotrichia investiens (Zanardini) Bornet	x	-
Erythrotrichia reflex (Crouan et Crouan) Thuret	x	-
FLORIDEOPHYCEAE		
A c r o c h a e t i a l e s		
Acrochaetiaceae:		
Acrochaetium daviesii (Dillwyn) Nägeli	c	-
Acrochaetium virgatulum (Harvey) Bornet	c	-
Rhodochorton sp.	r	-

	I Coastal area	II Open sea area
N e m a l i o n a l e s		
Chaetangiaceae:		
Galaxaura oblongata (Ellis et Solander) Lamour.	r	-
Helminthocladiaceae:		
Liagora viscida (Forsskaal) C. Agardh	r	-
Nemalion helminthoides (Valley in Withering) Batt.	r	-
G e l i d i a l e s		
Gelidiaceae:		
Gelidiella lubrica (K¸tzing) Feldman et Hamel	x	-
Gelidiella pannosa (Bornet ex J. Feldmann) Feldmann et Hamel	x	-
Gelidium crinale (Turner) Lamouroux	c	-
Gelidium latifolium (Greville) Thuret et Bornet		
var. *latifolium*	x	-
var. *hystrix* (J. Agardh) Hauck	x	-
Gelidium malanoideum Sohousboe ex Bornet		
var. *melanoideum*	x	-
var. *filamentosum* Schousboe	c	-
Gelidium pusillum (Stackhouse) Le Jolis		
var. *pusillum*	x	-
var. *minusculum* Weber van Bose	c	-
Gelidium spathulatum (Kützing) Bornet	x	-
Wurdemannia miniata (Lamoroux) Feldmann at Hamel	x	-
C r y p t o n e m i a l e s		
Rhyzophylidaceae:		
Contarinia peyssonneliaeformis Zanardini	x	-
Corallinaceae:		
Amphiroa cryptarthrodia Zanardini	x	-
Amhiroa rigida Lamoroux	x	-
Corallina granifera Ellis et Solander	x	-
Corallina officinalis Linnaeus	cc	-
Dermatolithon confinis (Crouan et Crouan) Boud.	x	-
Dermatolithon cystoseira (Hauck) H. Huvé	c	-
Dermatolithon pustulatum (Lamouroux) Foslie		

	I Coastal area	II Open sea area
Dermatolithon pustulatum (Lamouroux) Foslie		
var. *pustulatum*	c	-
var. *coralline* Foslie	x	-
Fosliella farinosa (Lamouroux) Howe	c	-
Fosliella lejolisii (Rosanoff) Howe	c	-
Jania rubens (Linnaeus) Lemouroux	x	-
Lithohyllum incrustans Philippi	x	-
Lithohyllum racemus (Lamarck) Foslie	c	-
Lithohyllum tortuosum (Esper) Foslie	c	-
Lithothamnium fruticulosum (Kützing) Foslie	x	cc
Melobesia membranacea (Esper) Lamouroux	c	-
Neogoniolithon notarisii (Dufour) Setchel et Mason	x	-
Phymatolithon calcareum (Pallas) Adey et Mc Kibbin	-	x
Phymatolithon lenormandii (Areschoug in J. Ag.) Adey	x	-
Pseudolithophyllum expansum (Philippi) Lemoine	x	-
Dumontiaceae:		
Acrosymphyton purpuriferum (J. Agardh) Sjöstedt	r	-
Dudresnaya verticillata (Withering) Le Jolis	x	-
Hildenbrandiaceae:		
Hilderbrandia rubra (Sommerfield) Meneghini	x	-
Kallymeniaceae:		
Kallymenia microphylla J. Agardh	x	r
Peyssonneliaceae:		
Peyssonnelia adriatica Hauck	x	-
Peyssonnelia polymorpha (Zanardini) Schmitz	x	x
Peyssonnelia rubra (Greville) J. Agardh	x	x
Peyssonnelia squamaria (Gmelin) Decaisne	x	-
G i g a r t i n a l e s		
Gigartinaceae:		
Gigartina acicularis (Roth) Lamouroux	x	-
Gracilariaceae:		
Gracilaria dura (C. Agardh) J. Agardh	r	-

	I Coastal area	II Open sea area
Hypneaceae:		
Hypnea musciformis (Wulfen) Lamouroux	x	-
Phyllophoraceae:		
Schottera nicaeensis (Lamour. ex Duby) Guiry et Holl.	c	-
Plocamiaceae:		
Plocamium cartilagineum (Linnaeus) Dixon	x	-
Rhabdoniaceae:		
Catenella repens (Lightfoot) Batters	cc	-
Rhodophyllidaceae:		
Rhodophyllis divaricata (Stackhouse) Papenfuss	x	x
R h o d y m e n a l e s		
Lomentariaceae:		
Champia parvula (C. Agardh) Harvey	c	-
Chylocladia verticillata (Lightfoot) Bliding	x	-
Lomentaria chylocladiella Funk	x	-
Lomentaria verticillata Funk	x	-
Lomentaria sp.	x	-
Gastroclonium clavatum (Roth) Ardissone	x	-
Rhodymeniaceae:		
Botryocladia botryoides (Wulfen in Jacquin) J. Feldm.	r	-
Botryocladia chiajeana (Meneghini) Kylin	x	-
Botryocladia microphysa (Hauck) Kylin	r	r
Rhodymenia ardissonei J. Feldmann	x	c
B o n n e m a i s o n i a l e s		
Bonnemaisoniaceae:		
Bonnemaisonia asparagoides (Woodward) C. Agardh	x	-
Falkenbergia rufolanosa (Harvey) Schmitz-stadium	c	-

	I Coastal area	II Open sea area
Ceramiales		
Ceramiaceae:		
Aglaothamnion caudatum (J. Agardh) Feldm.-Mazoyer	x	-
Aglaothamnion furcellariae (J. Agardh) Feldm.-Mazoyer	c	-
Aglaothamnion tenuissimum (Bonnem.) Feldm.-Mazoyer	c	-
Aglaothamnion tripinatum (Grateloup) Feldm.-Mazoyer	c	-
Antithamnion cruciatum (C. Agardh) Nägeli		
var. *cruciatum*	c	-
var. *profundum* G. Feldmann	x	-
Antithamnion heterocladum Funk	x	-
Antithamnion tenuissium (Hauck) Schiffner	x	r
Callithamnion corymbosum (Smith) Lyngbye	x	-
Callithamnion granulatum (Ducluzeau) C. Agardh	c	-
Ceramium ciliatum (Ellis) Ducluzeau	c	-
Ceramium codii (Richards) Mazoyer	c	-
Ceramium diaphanum (Lightfoot) Roth		
var. *diaphanum*	x	-
var. *lophophorum* Feldmann-Mazoyer	x	-
var. *strictum* (Kützing) Feldmann-Mazoyer	x	-
Ceramium gracillimum var. *byssoideum* Harvey	cc	-
Ceramium rubrum var. *barbatum* (Kützing) J. Agardh	x	-
Ceramium tenerimum (Martens) Okamura	x	-
Compsothamnion thuyoides (Smith) Schmitz	x	-
Crouania attenuata (Bonnemaison) J. Agardh	x	-
Griffithsia phyllamphora J. Agardh	r	-
Griffithsia schousboei Montagne	x	-
Gulsonia nodulosa (Ercegović) J. Feldm. et G. Feldm.	x	-
Gymnothamnion elegans Schousboe ex C. Agardh	r	-
Lejolisia mediterranea Bornet	x	-
Monosporus pedicellatus (Smith) Solier in Castagne		
var. *pedicellatus*	x	-
var. *tenuis*	x	-
Platythamnion plumula (Ellis) Boudouresque et al.		
var. *plumula*	c	-
var. *bebii* (Reinsch) J. Feldmann	cc	-
var. *crispum* (Ducluzeau) Hauck	cc	
Pleonosporium borreri (Smith) Nägeli ex Hauck	c	-
Ptilothamnion pluma (Dillwyn) Thuret in Le Jolis	r	-
Seirospora apiculata (Meneghini) G. Feldmann	x	-
Seirospora interrupta (Smith) Schmitz	x	-
Spermothamnion flabellatum Bornet	x	x
Spermothamnion johanis G. Feldmann-Mazoyer	x	-

	I Coastal area	II Open sea area
Spermothamnion repens (Dillwyn) Rosenvinge	x	-
Sphondylothamnion multifidum (Hudson) Nägeli	x	-
Dasyaceae:		
Dasya corymbifera J. Agardh	x	-
Dasya hutchinsiae Harvey in Hooker	x	-
Dasya ocellata (Grateloup) Harvey	x	-
Dasya sp.	x	-
Dasyopsis plana (C. Agardh) Zanardini	x	-
Dasyopsis spinella (C. Agardh) Zanardini	r	-
Heterosiphonia wurdemannii (Bailey) Falkenberg	x	-
Deleseriaceae:		
Acrosorium uncinatum (Turner) Kylin		
var. *uncinatum*	x	-
var. *venulosum* (Zanardini) Boudouresque	x	-
Apoglossum ruscifolium (Turner) J. Agardh	x	x
Arachnophyllum confervaceum (Meneghini) Zanardini	x	-
Erythroglossum sandrianum (Zanardini) Kylin	x	-
Hypoglossum woodwardii (Woodward) Kützing	x	-
Myriogramme tristromatica (Rodrig. et Mazza) Boud.	c	-
Nitophyllum punctatum (Stackhouse) Greville	x	-
Radicilingua reptans (Zanardini) Papenfuss	x	-
Radicilingua thysanorhizans (Holms) Papenfuss	c	c
Rhodomelaceae:		
Börgeseniella fruticulosa (Wulfen) Kylin	r	-
Chondria dasyphylla (Woodward) C. Agardh	x	-
Chondria tenuissima (Good. et Woodw.) C. Agardh	x	-
Dipterosiphonia rigens (Schousboe) Falkenberg	x	-
Halodictyon mirabile Zanardini	x	-
Herposiphonia tanella (C. Agardh) Ambronn		
f. t*enella*	c	-
f. *secunda* (C. Agardh) Hollenbepg	r	-
Laurencia obtusa (Hudson) Lamoroux	x	-
Laurencia papillosa (C. Agardh) Greville	x	-
Laurencia pinnatifida (Gmelin) Lamouroux	c	-
Lphosiphonia obscura (C. Agardh) Falkenberg	x	-
Lphosiphonia scopulorum (Harvey) Womersley	c	-
Polysiphonia elongata (Hudson) Sprengel	x	-
Polysiphonia opaca (C. Agardh) Morris et De Notaris	c	-

	I Coastal area	II Open sea area
Polysiphonia sertularioides (Grateloup) J. Agardh	x	-
Polysiphonia subulifera (C. Agardh) Harvey	x	-
Polysiphonia sp.	x	-
Rodriguezella strafforellii Schmitz ex Rodriguez	x	-
Rytiphlaea tinctoria (Clemente) C. Agardh	x	-
PHAEOPHYTA		
PHAEOPHYCEAE		
Ectocarpales		
Ectocarpaceae:		
Acinetospora vidovichii (Meneghini) Sauvegeau	c	-
Ectocarpus confervoides (Roth) Kjellman		
var. *confervoides*	x	-
var. *adriaticus* (Ercegović) Giaccone	x	-
var. *siliculosus* (Dillwyn) Kjellman	c	-
Feldmannia battersiides f. *sporangiosessilis* Erceg.	x	-
Feldmannia caespitula (J.Ag) Knoepffler-Peguy		
var. *caespitula*	cc	-
var. *lebelii Areschoug* ex Crouan et Crouan	c	-
Feldmannia irregularis (Kützing) Hamel		
ssp. irregularis	x	-
ssp. lebeliides Ercegović	x	-
Giffordia mitchelliae (Harvey) Hamel	x	-
Giffordia sandriana (Zanardini) Hamel	x	-
Ralfsiales		
Ralfsiaceae:		
Ralfsia verrucosa (Areschoug) J. Agardh	x	-
Chordariales		
Chordariaceae:		
Castagnea mediterranea (Kützing) Hauck	x	-
Liebmannia leveillei J. Agardh	x	-
Chorinophloeaceae:		
Leathesia mucosa J. Feldmann	x	-

	I Coastal area	II Open sea area
Myriactula elongata (Sauvageau) Hamel	x	-
Myriactula rivulariae (Suhr in Aresch.) J. Feldm.	x	-
Myriactula stellulata (Groffiths) Levring	c	-
Elachistaceae:		
Elachista fucicola (Valley) Areschoug	x	-
Elachista intermedia Crouan et Crouan	x	-
Myrionemataceae:		
Myrionema orbiculare J. Agardh	x	-
Spermatochnaceae:		
Spermatochnus paradoxus (Roth) Kützing	r	-
Stilophora rhizodes (Turner) J. Agardh	x	-
S p o r o c h n a l e s		
Sporochnaceae:		
Nereia filiformis (J. Agardh) Zanardini	x	-
C u t l e r i a l e s		
Cutleriaceae:		
Aglaozonia chillosa Falkenberg-stadium	c	-
Aglaozonia parvula (Grevile) Zanardini-stadium	x	-
Cutleria multifida (Smith) Greville	x	-
Zanardinia prototypus Nardo	x	-
S p h a c e l a r i a l e s		
Sphacelariaceae:		
Halopteris filicina (Grateloup) Kützing	c	r
Sphacelaria cirrosa (Roth) C. Agardh	c	-
Sphacelaria furcigera Kützing	cc	-
Sphacelaria fusca (Hudson) C. Agardh	c	-
Sphacelaria plumula Zanardini	c	x
Sphacelaria tribuloides Meneghini	c	-
Stypocaulon scoparium (Linnaeus) Kützing	c	-

	I Coastal area	II Open sea area
D i c t y o t a l e s		
Dictyotaceae:		
Dictyopteris membranacea (Stackhouse) Batters	x	-
Dictyota dichotoma (Hudson) Lamouroux		
var. *dichotoma*	c	-
var. *intricata* (C. Agardh) Greville	x	-
f. *proliferans* Ercegović	x	-
Dictyota linearis (C. Agardh) Greville	x	-
Dilophus fasciola (Roth) Howe	x	-
Padina pavonica (Linnaeus) Thivy	x	-
Taonia atomaria (Woodward) J. Agardh	x	-
D i c t y o s i p h o n a l e s		
Giraudiaceae:		
Giraudia sphacelarioides Derbes et Solier in Castagne	r	-
Punctariaceae:		
Asperococcus turneri (Smith) Hooker	r	-
Colpomenia sinuosa (Mertens) Der. et Sol. in Cast.	x	-
Petalonia fascia (Müller) Kuntze	x	-
Scytosiphon lomentaria (Lyngbye) Endlicher	c	-
Striariaceae:		
Styctyosiphon adriaticus Kützing	x	-
F u c a l e s		
Fucaceae:		
Fucus virsoides (Donati) J. Agardh	x	-
Cystoseiraceae:		
Cystoseira adriatica Sauvageau	x	-
Cystoseira barbata (Goodenough et Woodw.) C. Agardh	x	-
Cystoseira corniculata ssp. laxior Ercegović	x	-
Cystoseira stricta var. *spicata* (Ercegović) Giacc.	x	-
Cystoseira compressa (Esper) Gerloff et Nizamuddin	x	

	I Coastal area	II Open sea area
Sargassaceae:		
Sargassum vulgare C. Agardh	x	-
CHLOROPHYTA		
CHLOROPHYCEAE		
Ulotrichales		
Ulotrichaceae:		
Ulothrix flacoa (Dillwyn) Thuret	x	-
Ulothrix subflaccida Wille	x	-
Ulvales		
Monostromaceae:		
Blidingia minima (Nägeli ex Kützing) Kylin	c	-
Ulvaceae:		
Enteromorpha compressa (Linnaeus) Greville	c	-
Enteromorpha flexuosa (Wulfen ex Roth) J. Agardh	x	-
Enteromorpha intestinalis (Linnaeus) Link	x	-
Enteromorpha prolifera (Müller) J. Agardh	c	-
Enteromorpha multiramosa Bliding	r	-
Enteromorpha ramulosa (Smith) Hooker	x	-
Ulva rigida C. Agardh	c	-
Chaetophorales		
Chaetophoraceae:		
Ulvella lens Crouan et Crouan	r	-
BRYOPSIDOPHYCEAE		
Cladophorales		
Cladophoraceae:		
Chaetomorpha aerea (Dillwyn) Kützing	x	-
Chaetomorpha sp.	x	-

	I Coastal area	II Open sea area
Cladophora albida (Hudson) Kützing	x	-
Cladophora coelothrix Kützing	x	-
Cladophora dalmatica Kützing	c	-
Cladophora glomerata (Linnaeus) Kützing	c	-
Cladophora hutchinsiae (Dillwyn) Kützing	x	-
Cladophora laetevirens (Dillwyn) Kützing	x	-
Cladophora lehmanniana (Lindenberg) Kützing	x	-
Cladophora pellucida (Hudson) Kützing	r	-
Cladophora prolifera (Roth) Kützing	r	-
Cladophora sericea (Hudson) Kützing	c	-
Cladophora vagabundae (Linnaeus) Van den Hoek	x	-
Cladophora sp.	x	-
Rhizoclonium riparium (Roth) Harvey	c	-
S i p h o n o c l a d a l e s		
Valoniaceae:		
Valonia macrophysa Kützing	x	-
Valonia utricularis (Roth) C. Agardh	x	-
D a s y c l a d a l e s		
Dasycladaceae:		
Acetabularia acetabulum (Linnaeus) Silva	x	-
Dasycladus vermicularis (Scopoli) Krassar	x	-
D e r b e s i a l e s		
Derbesiaceae:		
Derbesia tenuissima (Moris et De Not.) Crouan et Cr.	x	-
Halicystis parvula Schmitz in Murray-stadium	x	-
C o d i a l e s		
Bryopsidaceae:		
Bryopsis cupressoides Kützing	r	-
Bryopsis duplex De Notaris	x	-
Bryopsis hypnoides Lamouroux	x	-
Bryopsis sp.	x	-

	I Coastal area	II Open sea area
Codiaceae:		
Codium bursa (Linnaeus) C. Agardh	x	-
Codium effusum (Rafinesque) Delle Chiaje	x	-
Codium vermilara (Olivi) Delle Chiaje	x	-
C a u l e r p a l e s		
Udoteaceae:		
Halimeda tuna (Ellis et Solander) Lamouroux	x	-
Pseudochlorodesmis furcellata (Zanardini) Börgesen	c	-
Udotea petiolata (Turra) Börgesen	x	-
-		
ANGIOSPERMAE		
MONOCOTYLEDONES		
Potamogetonaceae:		
Cymodocea nodosa (Ucria) Achers	c	-
Posidonia oceanica (Linnaeus) Delile	x	-

Table 12.4. List of benthic fauna and its relative abundance. (r = rare; x = up to 10; c = 11-100; cc = more than 100 specimens)

	I Coastal area	II Open sea area
PORIFERA		
Clathrina coriacea (Mont)	r	-
Leucosolenia variabilis (Haeckel)	r	-
Sycon raphanus (Schmidt)	x	-
Leuconia solida (Schmidt)	r	-
Oscarella lobularis (Schmidt)	r	-
Chondrosia reniformis Nardo	x	-
Chondrilla nucula Schmidt	x	-
Geodia cydonium (Jameson)	x	-
Tethya aurantium (Pall.)	r	-
Spirastrella cunctatrix Schmidt	x	-
Timea unistellata Topsent	r	-
Suberites domuncula (Olivi)	-	c
Suberites carnosus (Johnston)	-	cc
Cliona celata (Grant)	x	x
Cliona sp.	x	-
Erylus discophorus (Schmidt)	-	x
Mycale sp.	-	x
Myxilla rosacea (Lieberk.)	-	c
Tedania anhelans (Lieberk.)	-	c
Raspailia viminalis Schmidt	-	r
Chlathria coralloides (Olivi)	-	r
Clathria sp.	r	-
Petrosia ficiformis Poiret	-	r
Siphonochalina crassa Topsent	-	c
Spongia officinalis L.	x	r
Spongia virgultosa (Schmidt)	r	-
Cacospongia mollior Schmidt	-	r
Cacospongia scalaris Schmidt	x	r
Hippospongia communis (Lam.)	-	r
Verongia aerophoba (Schmidt)	x	-
Verongia cavernicola Vacelet	-	x
Ircinia dendroides (Schmidt)	x	-
Ircinia variabilis Sarra	x	-
Ircinia fasciculata (Pall.)	x	-
Ircinia foetida (Schmidt)	-	r
Ircinia sp.	-	x
CNIDARIA		
Actinia cari Delle Chiaje	r	-
Actinia equina (L.)	r	-
Anemonia sulcata (Penn.)		

Calliactis parasitica (Couch)	-	x
Adamsia palliata (Bohadsch)	-	c
Caryophyllia clavus Sacchi	-	x
Cladocora cespitosa (L.)	r	-
Alcyonium palmatum Pall.	-	x
Virgularia mirabilis (Müler)	-	cc
Balanophyllia sp.	r	-
Pteroides spinosus (Ellis)	-	cc
ANNELIDA		
Aphrodita aculeata L.	-	x
Sabella pavonina Sav.	r	-
Spirographis spallanzani Viviani	x	-
Ditrupa arietina Müller	-	x
Serpula vermicularis L.	x	c
Spirorbis pagenstecheri Qatref	x	x
Hyalinoecia tubicola (Müller)	-	c
Pomatoceros triqueter (L.)	x	x
Hermione hystrix (Sauv.)	-	x
Vermiliopsis infundibulum (L.)	r	-
Sternaspis scutata (Renier)	-	c
Spirorbis sp.	c	-
POLYCHAETA indet.(ERRANTIA)	c	-
ARTHROPODA		
Atelecyclus rotundatus (Olivi)	-	r
Chthamalus depressus (Poli)	c	-
Chthamalus stellatus (Poli)	c	-
Balanus perforatus Brug.	x	-
Balanus amphitrite Darwin	x	-
Balanus trigonus Darwin	x	-
Chelonibia testudinaria (L.)	x	x
Portunus depurator (L.)	-	c
Pagurus arosor (Herbst)	-	x
Pagurus variabilis (Milne Edw. et Bouv.)	-	x
Paguristes oculatus (Fabr.)	-	c
Eupagurus prideauxi (Leach)	-	c
Eupagurus sp.	-	x
Galathea nexa Embl.	-	x
Nephrops norvegicus (L.)	-	x
Galathea sp.	-	x
Macropodia longipes (Milne Edw. et Bouv.)	-	x
Macropodia rostrata (L.)	x	cc
Macropodia longirostis (Fabr.)	-	x
Ligia italica Fabr.	c	-
Gonoplax angulata (Penn.)	-	cc
Liocarcinus depurator (L.)	-	cc

Macropodia linaresi Forest et Alvarez	-	x
Dromia vulgaris Milne Edw.	-	r
Ethusa mascarone (Herbst)	-	cc
Inachus dorsettensis (Penn.)	-	cc
Achaeus cranchi Leach	r	-
Pachygrapsus marmoratus (Fabr.)	x	-
Maya squinado (Herbst)	-	x
Pisa nodipes (Leach)	-	x
Pilumnus hirtellus (L.)	-	cc
Squilla mantis Fabr.	-	r
MOLLUSCA		
Acanthochiton communis (Risso)	x	-
Acanthochiton fascicularis (L.)	x	-
Callochiton laevis (Montagu)	r	-
Middendorfia caprearum (Scacchi)	x	-
Calliostoma conulus (L.)	x	-
Calliostoma granulatum (Born)	-	r
Calliostoma zizyphinus (L.)	x	-
Jujubinus striatus (L.)	x	-
Haliotis lamelosa Lam.	x	-
Calyptraea chinensis (L.)	x	x
Aporrhais pespelecani (L.)	-	c
Murex brandaris L.	x	c
Muricidea blainvillei (Payr.)	x	-
Turritella communis Risso	-	c
Turritella triplicata (Brocchi)	-	x
Triphora perversa (L.)	r	-
Diodora gracea (L.)	x	-
Diodora italica (De France)	r	-
Fusinus rostratus (Olivi)	r	x
Scaphander lignarius (L.)	-	x
Patella aspera (Philippi)	x	-
Patella lusitanica (Gmelin)	x	-
Patella coerulea L.	x	-
Acmaea virginea (Müller)	r	x
Philine aperta (L.)	-	cc
Galeodea echinophora (L.)	-	r
Gibbula divaricata (L.)	r	-
Gibbula biasoletti (Philippi)	r	-
Gibbula racketti (Payr.)	r	-
Vermetus arenarius (L.)	x	-
Conus mediterraneus Bruguiere	r	-
Columbella rustica (L.)	r	-
Pisania maculosa (Lam.)	r	-
Cantharidus exasperatus (Penn.)	x	-

Monodonta turbinata (Born.)	x	-
Clanculus cruciatus (L.)	x	-
Littorina neritoides (L.)	c	-
Rissoa violacea Desm.	c	-
Rissoa decorata Phil.	x	-
Rissoa ventricosa Desm.	x	-
Rissoa splendida Eich.	x	-
Bittium reticulatum Da Costa	c	-
Capulus hungaricus (L.)	r	x
Crepidula moulinsi Michaud	r	-
Muricopsis cristatus (Brocchi)	x	-
Isocardia cor (L.)	-	r
Nassa incrassata (Müller)	x	-
Nassa costulata (Ren.)	x	-
Chione ovata (Penn.)	-	cc
Aplysia sp.	x	-
Ostrea edulis L.	x	cc
Arca noae L.	x	-
Arca barbata L.	x	-
Brachyodontes minimus (Poli)	c	-
Musculus discorus (L.)	x	-
Musculus costulatus (Risso)	x	-
Lithophaga lithophaga (L.)	cc	-
Musculus marmoratus (Forbes)	x	-
Mytilus galloprovincialis Lam.	c	cc
Flexopecten flexuosus (Poli)	x	-
Natica millepunctata Lam.	-	x
Nucula sulcata (Bronn.)	-	x
Telinella pulchella (Lam.)	-	x
Tellinella distorta (Poli)	-	x
Irus irus (L.)	x	-
Petricola lithophaga Retzius	x	-
Pinna pectinata L.	-	c
Hiatella arctica (L.)	x	-
Hiatella striata (Fleuriau-Bellevue)	r	-
Chlamys opercularis (L.)	c	cc
Chlamys varius (L.)	x	x
Gastrochaena dubia (Penn.)	x	-
Anomia ephippium (L.)	x	cc
Chama gryphoides L.	x	-
Laevicardium oblongum (Gmelin)	-	r
Cultrensis adriaticus (Coen)	-	x
Ensis ensis (Coen)	-	r
Lyonsia striata (Montagu)	-	r
Aloidis gibba (Olivi)	-	cc
Hinia limata (Chemnitz)	-	x
Pecten jacobaeus (L.)	-	r

Pitaria rudis (Poli)	-	x
Lima inflata (Chemnitz)	-	x
Mantellum hians (Gmelin)	-	r
Venerupis aureus (Gmelin)	-	r
Allotheutis media (L.)	-	r
Ommatostrephes sagitatus (Lam.)	-	x
Loligo vulgaris (Lam.)	-	r
Sepia officinalis L.	r	x
Sepia orbignyana Ferrusac	-	r
Sepia elegans D'Orbigny	-	x
Eledone moschata (Lam.)	-	x
TENTACULATA		
Argyrotheca cistellula Wood	x	-
Scrupocellaria reptans L.	x	-
Myriozoum truncatum (Pall.)	x	x
Schizoporella sanguinea Norman	x	-
Hippodiplosia foliacea (Ellis et Sol.)	x	-
Retepora beaniana King	x	x
Lichenophora radiata Aud.	c	-
Cellepora pumicosa Hincks	x	-
Tubulipora flabellaris Fabr.	r	-
ECHINODERMATA		
Antedon mediterranea (Lam.)	x	x
Holothuria forskali Delle Chiaje	-	cc
Holothuria tubulosa Gmelin	x	c
Holothuria sp.	-	c
Cucumaria planci Brandt	-	cc
Cucumaria elongata Düb. et Kor.	-	r
Stichopus regalis (L.)	r	r
Pseudothyone raphanus (Düb. et Kor.)	-	x
Astropecten irregularis (Linck)	-	cc
Astropecten aurantiacus (L.)	-	x
Astropecten spinulosus (Philippi)	x	-
Anseropoda placenta (Linck)	x	x
Echinaster sepositus Gray	x	x
Marthasterias glacialis (L.)	x	r
Ophiothrix quinquemaculata (Delle Chiaje)	-	cc
Ophiothrix fragilis (Abild.)	x	-
Amphiura chiajei Forbes	-	c
Amphiura filiformis O.F. Müller	-	c
Amphipholis squamata (Delle Chiaje)	r	-
Ophiura albida Forbes	r	cc
Ophioderma longicauda Linck.	r	-
Thyone cherbonnieri (Reys)	-	r
Trachytyone tergestina (Sars)	-	r

Ophiura texturata Lam.	-	cc
Echinocyamus pusillus (O.F. Müller)	-	x
Echinocardium cordatum (Penn.)	-	r
Psamechinus microtuberculatus (Blainv.)	x	cc
Sphaerechinus granularis (Lam.)	r	-
Echinusacutus Lam.	x	cc
Paracentrotus lividus Lam.	x	-
Arbacia lixula (L.)	x	-
TUNICATA		
Didemnum maculosum (Milne Edw.)	x	-
Diplosoma listerianum (Milne Edw.)	r	-
Distomus variolosus Gaertner	r	-
Phallusia mamillata (Cuvier)	x	c
Bothryllus schlosseri (Pallas)	x	c
Distoma adriaticum Drasche	x	c
Aplidium conicum Olivi	-	x
Pyura dura (Heller)	x	-
Ascidia mentula (Müller)	r	r
Ascidia virginea (Müller)	-	x
Ascidia sp.	r	-
Microcosmus sulcatus Coquebert	x	c
Halocynthia papillosa L.	r	-
CHONDRICHTHYES		
Galeus melastomus Rafinesque	-	r
Scyliorhinus canicula (L.)	-	r
Mustelus asterias Cloquet	-	r
Mustelus mustelus (L.)	-	r
Squalus acantias (L.)	-	r
Torpedo marmorata Risso	-	r
Raja clavata (L.)	-	r
Myliobatis aquila (L.)	-	r
OSTEICHTHYES		
Sardina pilchardus Walb.	-	x
Sprattus sprattus sprattus (L.)	-	x
Alosa falax nilotica (E.G.Saint-Hilaire)	-	r
Engraulis encrasicholus (L.)	-	r
Conger conger (Artedi) L.	r	r
Merluccius merluccius (L.)	-	x
Merlangus merlangus euxinus (Nordmann)	-	x
Trisopterus minutus capelanus (Lacep.)	-	x
Antonogadus megalokynodon (Kolombat.)	-	r
Zeus faber L.	-	r
Serranus hepatus (L.)	x	x
Cepola macrophthalma (L.)	-	x

Trachurus trachurus (L.)	-	x
Trachurus mediterraneus mediterraneus (Steinacher)	-	x
Boops boops (L.)	x	x
Mullus barbatus L.	-	x
Mullus surmuletus L.	-	r
Diplodus annularis (L.)	x	r
Diplodus vulgaris (E.G.Saint-Hilaire)	x	x
Lithognatus mormyrus (L.)	r	r
Pagellus erythrinus (L.)	-	x
Pagellus acarne Risso	-	x
Spicara maena flexuosa Rafinesque	-	r
Spicara smaris (L.)	x	x
Trachinus draco (L.)	-	r
Symphodus cinereum (Bonnaterre)	-	r
Uranoscopus scaber (L.)	-	r
Scomber scombrus L.	-	r
Gobius niger L.	-	r
Deltentosteus quadrimaculatus (Valenc.)	-	r
Callyonymus maculatus Rafinesque	-	r
Blennius ocellaris L.	-	r
Liza aurata (Risso)	r	r
Scorpaena scrofa L.	r	r
Scorpaena porcus L.	r	r
Scorpaena notata Rafinesque	-	x
Aspitrigla cuculus (L.)	-	x
Triglia lucerna L.	-	r
Eutrigla gurnardus (L.)	-	x
Lepidotrigla cavillone (Lacepède)	-	r
Trigloporus lastaviza (Brunnich)	-	x
Phrynorhombus regius (Bonnaterre)	-	r
Scophthalmus rhombus (L.)	-	r
Arnoglossus laterna (Walbaum)	-	x
Pseta maxima (L.)	-	r
Arnoglossus thori Kyle	-	r
Platichthys flescus italicus (Gunther)	-	r
Solea vulgaris vulgaris Quensel	-	x
Solea kleini Risso Bonaparte	-	r
Buglossidium luteum (Risso)	-	x
Microchirus variegatus (Donovan)	-	r
Monochirus hispidus Rafinesque	-	r
Lophius piscatorius L.	-	r
Lophius budegassa Spinola	-	r

Table 12.5. Average values of the relative index of the abundance (kg/hour) of the main groups of the benthic organisms on the stations of profiles B and C in the northern Adriatic as well as total biomass and average values of all groups on each station during both cruises in 1982-1983 years.

	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	C_2	C_3	C_4	C_5	C_6	C_7	TOTAL	AVERAGE
Porifera	15.49	37.71	11.30	0	0	12.05	1.23	47.63	0	0.04	16.58	11.70	15.63	59.10	228.46	16.32
Cnidaria	0.42	0	0	0	0.34	0	0	0	2.66	0.02	0.08	0	0.91	18.43	22.86	1.63
Annelida	0	0	0	0	3.34	0	0	0	0.20	0.03	0	0.53	0	0.10	4.20	0.30
Arthropoda	147.20	88.79	360.35	149.13	450.35	4.95	236.61	11.84	32.20	76.26	7.83	8.10	24.00	3.65	1641.26	117.23
Mollusca	27.88	57.58	452.08	0	140.89	45.43	0.98	171.84	27.41	123.92	33.70	1048.33	1147.82	37.31	3315.17	236.80
Echindodermata	9.76	15.24	21.02	1.98	110.60	48.62	3.13	139.25	20.16	21.55	161.24	140.34	295.62	284.49	1273.00	90.93
Tunicata	2.77	25.03	0	0	1.18	3.20	0	67.78	0	2.73	7.43	4.19	9.72	26.25	153.28	10.95
Total	203.52	227.35	844.75	151.11	746.70	114.25	241.95	438.34	82.63	224.55	226.86	1213.19	1493.70	429.33	6638.23	474.16